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An Analysis of Natural Factors Affecting the Dispersal and Establishment of Iron Age III (800-550 B.C) Settlements in the Western Zayandeh-Rud River Basin (West and Northwest of Isfahan)

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ABSTRACT

Humans are always effect to their surroundings, which makes it possible to create habitable environments and create habitat patterns that fit the surrounding environment. The interaction between human being and environment either in the form of human effect on the environment or the environment effect on the human, cannot be considered out of the environment. According to this approach in archaeology, environmental factors have an important role in assessing settlements in each period. In addition to the recognition of the degree of environmental impact, this approach makes the degree of adaptation of the habitats with the dominant environmental conditions possible. As geospatial tools become more powerful, GIS archaeology has evolved as well, making it possible to visualize ancient settlements and analyze changes in the use of space over time. By incorporating historic map data, physical details of an area's landscape and known information about past inhabitants, archaeologists can accurately predict the positions of sites with cultural, historical relevance. In this research Iron Age III (800-550 B.C)sites in the west and northwest of Isfahan were studied via GIS. The area studied is one of the most important but unknown areas of archaeological research due to its location in the center of the Iranian plateau and a link between the north-west and the south-west of the country. The environmental characteristics of the studied area have attracted the attention of humans since ancient times. Therefore, it was considered necessary to conduct archaeological excavations. To achieve this goal, the area was first studied archaeologically. As a result of this survey, approximately 50 ancient sites were identified which included the statistical population used for analysis. The effect of environmental variables including altitude, slope (percentage and direction), climate, geological structure, distances and proximity to water resources, land use and proximity to communication paths on the distribution of settlements in the study area was investigated. Through analytical-descriptive method, the factors affecting the formation and distribution of the establishment patterns of the period in question were examind. After analyzing the information and maps, the results indicated that among all the factors, three environmental factors were the most important in the formation of ancient settlements of the Iron Age III era in the west and northwest of Isfahan: factors relating to water resources, proximity to communication paths, and slope percentage and direction.

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1. Introduction

Geographical Information Systems has moved from the domain of the computer specialist into the wider archaeological community, providing it with an exciting new research method^[1]. In fields where map-based data collection, data handling and service are in use, it is indispensable to use this modern solution. In addition to conventional technical applications, GIS became accepted in other disciplines too. Disciplines in the field of humanities are not exceptions to this concept^[2]. For decades, GIS has been an integral part of archaeological practice and its many advantages and uses in visualizing and managing archaeological data have been discussed as well as examined from a critical and theoretical perspective^[3]. Since the early 1990s one area of computer usage in archaeology, the use of Geographic Information Systems (GIS), has grown exponentially reflecting the importance of working with spatial data and spatial analyses of various kinds. Although this post-dates much of the theoretical debate taking place during the decades from the 1960s to 1980s, the use of GIS rekindled aspects of those debates albeit within a spatial context and will be used here to illustrate some of the tensions that still exist between archaeological computing and theory^[4].

GIS (Geographic Information System) is a highly important tool aiding in archaeological field studies in understanding the relationship between ancient sites and the environment as well as natural resources, and in defining interregional cultural boundaries. In the late 1960s, the analysis of ancient settlements became a key component of archaeological research's extensive questions regarding human adaptation to environmental diversity in a landscape^[5]. Considering all the theoretical discussions concerning the use of the GIS system from 1960 to 1980, Luke emphasized that GIS was the most helpful tool in analyzing spatial information^[6]. From the late 1990s onward, archaeologists have sought to make greater use of GIS in their research to provide an overview of the distance between archaeological sites with the aid of data and environmental variables^[7]. This points to the importance of applying new approaches and techniques in archaeology and suggests the need to apply and develop such techniques as a central part of any modern archaeological investigation. Concern for these questions and with the overall potential that information systems provide to capture, represent, analyze, and model archaeological information implies the need for a new interdisciplinary focus, archaeological information Science. For such a focus to prosper, archaeologists need to develop additional skills that go beyond mere technical ones^[8].

Archaeology not only reveals the past, but as a fundamental discipline in the humanities also plays a role in sustainability studies. Natural factors in creating and establishing settlements, physical-spatial and communication development act in different ways and in different places their positive aspects are highlighted while their negative effects are limited^[9]. Environmental capabilities (natural and human) provide the basis for the establishment of human settlements in geographical spaces. In fact, the spatial structure of each place is the manifestation of the interaction between human society and its physical environment^[10]. One of the requirements for examining the relationship between settlements in archeology and the environment is the coordination between the two parts. Understanding these conditions helps to know the strengths and limitations. Geography helps to achieve a perception of the interconnection between nature and man in geographic space; hence, "archaeologists and geography today share much in common"^[11]. Human endeavor to change the environment has been made through knowledge and adaptation to the environment, and this is a great effort that has led humans to dominate the environment and formulate civilizations^[12]. Establishment and emergence of a city are subject to environmental conditions and geographic location to a greater degree than any other factor^[13]. The pattern of establishment which is in fact a way of adapting man to the vision that they live in inevitably requires the identification of the environmental factors which are considered influential factor^[14]. Archaeologists interpret the settlement patterns of a region by collecting data from exploration and other techniques using social and environmental perspectives^[15]. The establishment of human societies has always been in the pursuit of natural resources and the natural environment. Choosing the right place to settle is often influenced by a variety of factors such as nature, business and economic incentives. Natural factors take into account topography, water resources, climate, remoteness and proximity to communication pathways in addition to other factors. These natural factors, in the form of a geographic space, with the activities and manipulations of the environment by humans create a cultural model that is somewhat recognizable in archeology. Sometimes the environmental conditions provide a suitable framework for human habitation such as appropriate heights, slope percentages and directions, water resources, land use, and geological structures.

The use of GIS, as a valuable aid in understanding geographic information, can be extremely helpful in storing and analyzing information and preparing maps. Archaeological studies, on the one hand, seek to identify archaeological sites and, on the other hand, aim to iden-

tify the relationship between archaeological sites and the environment as well as geography of each region. GIS provides data on altitudes, geology, access to water resources, land gradient surveillance, and more; therefore, it is highly effective in understanding the human relationship with the environment. Accordingly, it can be used to help archaeologists in the analysis of archaeological sites and relationship with the environment. The type of information provided in GIS to the archaeologist in the study of archaeological sites demonstrates that the formation of an archaeological site is not based on a random distribution pattern, and humans are modeled based on the conditions of their environment and thus chose their place of residence according to shape of the land, access to water resources, land slope, and land use. Analysis of this information helps archeology to determine the type of environmental use by humans. The result of this overlap of GIS and archaeological information contributes to assessment of archaeological sites using a topographic indicator. Hence the GIS information system assists archaeologists in analyzing spatial patterns and examines an archaeological site in terms of components such as altitude, slope percentage, geology, water resources, and communication routes. The connection between ancient sites and geographical data is finally presented as a map.

From the archaeological point of view, Isfahan Province is not well-known in relation to peripheral areas such as Fars and Khuzestan Provinces. From the prehistoric to the historical period, other than a few studies that have been undertaken in recent years which have led to a little understanding of this era, not much else is known. However, the midwest and north-west of the province due to the presence of high mountains, middle-mountain valleys and plains and nomadic settlements have been of interest since the distant past. Furthermore, due to its location between the western, south-west and central plateaus, it is an intermediary for cultural exchange between mountainous areas and plains. Therefore, recognition of the pattern of settlement and the effect of natural factors on the distribution of the sites of this era were taken into consideration. In the study of these settlements and their distribution, the variables that were considered from a geographical perspective were height, land use, remoteness and proximity to communication paths and water resources. In this research, using maps, the layout of Iron Age III sites identified in the West and North-West areas of Isfahan Province, which is a very important but unknown region, was investigated and analyzed. This research aims to answer the question of whether the formation and pattern of dispersion of settlements in the studied region were influenced by the mentioned conditions. In the studied area,

it appears that environmental factors provide the conditions for habitation, although they are different in terms of impact. For this reason, factors such as slope, altitude, climate, percentage and direction of slope, geological structure, water resources and distances, and proximity to communication routes were considered to study the effect of natural factors on the distribution of Iron Age III settlements. In order to determine the effectiveness of the above factors, it was necessary to use GIS to determine the distribution of sites in relation to these factors. Analysis of the patterns of establishment elevates our knowledge of the cultural landscape of the region; it appears that in the studied area, environmental factors provide the necessary conditions for establishing settlements but they differ in their degree of impact.

2. Iron Age III Archeology in Iran

The transitional period between the Bronze Age and the Iron Age in Iran and the conditions at the beginning of the Iron Age is one of the most widely discussed subjects in Iranian archaeology and there is still no real consensus between archaeologists and historians. Iron Age is one of the most revolutionary periods in the history and civilization of Iran and neighboring countries. In Iran the term Iron Age is employed to identify a cultural change that occurred centuries earlier than the time accorded its use elsewhere in the Near East, and not to acknowledge the introduction of a new metal technology. Iron artifacts, in fact, were unknown in Iran until the 9th century BC. The Iron Age in Iran occupies a relatively short time span in archaeological terms, Iron I: 1250-1050 B.C, Iron II: 1050-800 B.C, Iron III 800-550 B.C. The term "Iron Age III" entered the Iranian archaeological literature with the studies of Dyson and Young at the Hasanlu site. This period covers the historical period of 800-550 B.C. Characteristic of the Iron III period in western Iran (known mostly from surveys) is the presence of many local ceramic assemblages consisting of both plain and painted wares, indicating a variety of regional developments, perhaps indicating discrete polities. The studies of this historical period became more coherent by explorations of the Silk region, Hasanlu^[16], Nosh-I-Jan^[17], Godin^[18] and Baba Jan sites^[19]. In the Iranian chronological calendar, it is associated with the presence of the Medes in the region and the formation of the Medes from approximately 800 to 550 BC and before the Achaemenid Kingdom. In addition to the extension of the Medes territory to the central plateau, in Greek sources, such as Herodotus, refer to the Parthians as the second Median tribe, which some researchers have regarded as the geographical location of present-day Isfahan.

3. Geolocation of the Study Area

The study area according to the distribution of Iron Age III sites includes several cities with northwest-southeast extensions, the northwest end of which is the newly isolated city of Boeing and Miyandasht with a geographical position of 50 degrees, 9 minutes and 54 seconds east longitude, and 33 degrees, 4 minutes and 25 seconds north latitude while the southern end of the city of Isfahan has a geographical position of 51 degrees, 40 minutes and 6 seconds east longitude and 32 degrees, 39 minutes and 15 seconds north latitude. The cities of Boein and Miyandasht, Dardan, Fereydoun-Shahr, Chadegan, Tiran and Karan and north of Isfahan are the areas of interest in this research. Geographically, this area is bordered by Khansar to the north, Khorramabad and Chahar Mahal and Bakhtiari to the west, Na'in and Ardestan to the east and Lenjan, Mobarakeh, Shahreza and Chaharmahal and Bakhtiari provinces to the south. (Figure 1)

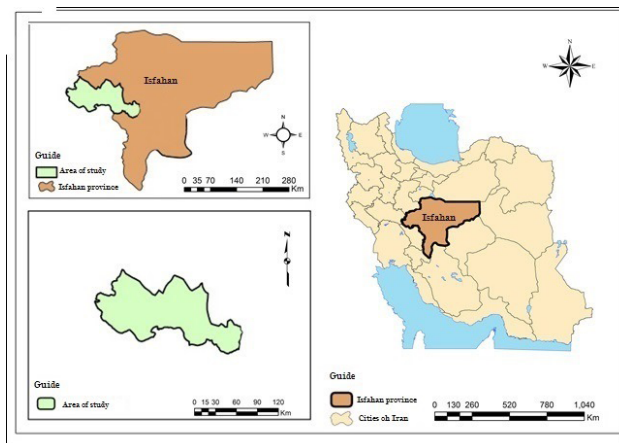


Figure 1. Map showing the area of study

Source: Field Survey (2018)

This area has two very different geographical landscapes. One of the most prominent features of this area is the existence of heights above 3000 meters and open plains with a height of 1860 meters next to each other. The north-west and west of the area has lands with an elevation of more than 2000 meters and land degradation in the form of narrow and parallel valleys, and very small plains separated by heights. In this region, the climate is cold and humid due to high altitudes and moisture absorption that flows to the Atlantic Ocean and the Mediterranean Sea to the east. In addition, the lack of development of communication paths and the extreme environmental conditions are factors in the absence of large urban centers and migration out of this basin, particularly the plains of Isfahan^[20]. Surface rivers and their inlets are the main environmental

phenomenon of these valleys that originate from Bakhtiari and Khansar mountains. Most of the current population centers are located near these water resources and on the upstream terraces of these rivers. The mountain valleys of Daran are larger than Fereydoun-Shahr and Boeing and have provided the possibility of aquatic farming. The natural feature of the region is that from the west and northwest to the east, a tangible change from mountains to plains can be observed where in fact the area is covered with alluvial heights. One of the best of these plains is the Zayandeh-Rud River plain. This area, which originates from grassland alluvials and ends with a slope to the Gavkhoni lagoon in the southeast of Isfahan, lies between the two western mountain ranges. The most important elevations of the Dalan-kuh, Bizeh and Damandar areas and the highest peaks of the Khan-kuh are 4040 meters above sea level^[21]. The studied basin is a cold mountainous region with relatively high rainfall, particularly in Daran and Fereydoun-Shahr (250-450 mm of rainfall per year). This part of the basin has a cold climate with temperatures as low as -20 degrees Celsius in January and February, and cool summers with temperatures between 25 and 30 degrees Celsius suitable for the tribes of the region. The highest atmospheric precipitation is in the form of snow, its level in millimeters varying from year to year. The vegetation in the western half is pasture in the form of shrubs and shrubs of the Zagros type, similar to those found in Lorestan and Bakhtiari. Varieties of birds such as eagles, ducks, quails, pigeons and doves and animals such as wolves, jackals, hogs, rams, goose, mice, rabbits and wild cats. Due to the type of climate, the studied area was a perfect area for nomadic settlers. The forced settling of nomadic tribes at the threat of the bayonet began in 1929, and gradually all the nomads became permanent settlers of the area^[22]. The present study mostly identified migratory settlements. Because of the proximity of Garm-sir (Gheshlagh/ warmer areas) to Sardsir (Yelagh / cooler areas), created livelihoods were based on migratory economic coexistence. In fact, people chose this lifestyle to adapt to the environment. The tribes of this area would go to Khuzestan (south) during the cold season and returned to the region in the hot season.

4. Statistical Population of the Study

In the western and northwest areas of Isfahan Province, an area of approximately 22700 square kilometers (excluding Khomeini, Shahr, Falavarjan and Najaf-Abad), Iron Age III sites were identified extending from Boein and Miyandasht to the urban centre of Isfahan city. Of the 48 sites, 2 sites are located in Boeing and Miyandasht, 10

sites in Fereydoun-Shahr, 19 sites in Daran, 14 in Chadegan, 3 in Tiran and Krvan and 1 in Isfahan city. In Najaf Abad, Khomeini Shahr and Falavarjan, which is located in the western and southern parts of the province, no areas have been identified thus far. Geographic maps were used to analyze these areas and the impact of environmental factors on how they are arranged. To do this, and for greater integration of the maps, Najaf Abad, Khomeini Shahr and Falavarjan were also included in the maps even though no Iron Age III enclosures were found.

5. History of Historical and Archaeological Research of the Study Area

The oldest evidence of the existence of ancient sites in the west of Isfahan Province is the Najm al-Molk (1983) travelogue which mentions visiting several ancient sites in the city of Chadgan. Maxim Siro(1978) also cited a cemetery with megalithic tombs in the area. Subsequently, two specialist teams from the former Department of Anthropology and Popular Culture, were dispatched in 1958 (Yahya Kusari), to identify and record the ancient sites of Shahrekord, and in 1979 to study the areas that would be submerged by the Zayandeh-Rud River dam during water drainage.

The first team referred to several hills including the Kogang on the border between the two provinces of Chaharmahal-Bokharti and Isfahan which although from their perspectives was not valuable, a number of pottery pieces relating to the Copper and Stone Ages and the beginning of the Elamite period were collected from the surface of the hill^[23]. Subsequently, Salehi completed a brief review of the Zayandeh-Rud River / Pasazgan Basin in the Tal-Balagh villages in 2001 extending to the Zayandeh-Rud River connection. Between 2001 and 2005, a part of the Chadegan city of Dolatabad and Kogang in the west, Chadegan in the east, and the north coast of Zayandeh-Rud River were investigated. In this study, sites of the Copper and Stone Ages until the Islamic period were identified. In addition to artifacts belonging to Iron Age I and II, pottery dating back to Iron Age III were also found from a number of sites including the typical bright red to chickpea and pink colored bowls, Cebu and dishes with horizontal handles.

Other field works carried out in this area include the exploration of the "Gourtan ancient site"^[24], "Review of prehistoric sites of Zayandeh-Rud River basin to Gavkhoni lagoon" as part of a PhD thesis^[25], "Review of the city of Fereydoun-Shahr"^[26], "Review of the Tiran and Karan townships"^[27], "Review of the city of Daran"^[28] and Distribution of copper-stone sites on the margin of

the Plasagan River in the central part Daran County. Recently, a study was carried out with the aim of identifying Iron Age III sites through reviewing results of previous surveys as well as identification of newer sites in Daran, Fereydoun-Shahr, Boyin and Miyandasht, Tiran-Krone and Chadegan^[29].

6. Method of Research

The present research aimed to analyze settlement patterns of the Iron Age III era in the study area using GIS (Geographic Information System (GIS)). The library-field method was used to collect the required data. The basic information was collected from books, documents and maps and completed with field studies. To prepare the maps of the region, based on the current review and the previous surveys, the sites were reviewed and recorded as points using the GPS device. The aim was to accurately analyze the ancient sites of this region in relation to the ecological characteristics of their settlements and their relative location along areas of natural resources. To achieve the desired goals, data on altitudes, slopes, landforms, land use, climate, rivers, communication paths and enclosures were input into the GIS maps software as layers. Each of the factors (layers) was compared to the sites and then evaluated. Then, each of these factors was analyzed in relation to the distribution and establishment of ancient sites. Finally, considering the output data, the distribution and the effect of geographic factors on the desired model extraction was studied. By preparing these information layers, analysis of environmental capabilities to adapt to the ancient sites and the settlement patterns of the area under study helped to determine their distribution status relative to the natural factors in the Iron Age III era. This research was based on a descriptive-analytic method with an emphasis on the role of natural factors in the distribution of Iron Age III settlements in the west and northwest of Isfahan Province.

6.1 Status of Deposits and Dispersion of Iron Age III Plots by Analyzing Environmental Variables

Environmental factors are usually considered in archaeological study models for a variety of reasons. Environmental data in the form of soils, geology, hydrology, and topographic maps are relatively easy to grasp. In addition, all classes and types of culture from simple collector-predator societies and primary farmers to advanced farmers and urban people respond to environmental conditions in their area of activity and settlement^[30]. According to Toulon, habitation is an integral part of human life and

its most important needs influence factors affecting the distribution of population and habitats in environmental variables including climate, vegetation, water resources, ripples (altitude and slope) and so on^[31]. It is important to note that the area under study has attracted humans in different periods because of suitable geographical and environmental conditions and natural resources. Various factors were taken into consideration in the selection of an ancient site by human populations. Sometimes although one factor is more prominent, usually it is a part of a group of inter-related factors. Among the natural factors affecting the distribution of ancient settlements height, water resources, soil, slope percentage and direction, vegetation, and communication paths were investigated.

6.2 The Location of the Enclosures Relative to Sea Level

One of the important issues in the study of ancient sites is the recognition of different altitude levels. The results of these surveys can provide archaeologists with valuable information concerning the new ancient sites and the location of the sites in the past. Altitude in mountainous areas is one of the most important factors in the establishment of settlements because the height in addition to the influence of climatic elements such as temperature, precipitation and evaporation, affect the production of soil and appropriate or inappropriate conditions of residence^[32]. Among the effects of climate on the altitude factor, one can study the number of freezing days and its impact on human biological activities^[33].

Two distinct climatic conditions of mountains and plains exist in the study area. The west and northwest, closer to the center and parts of the south-east are covered by lowlands and more often with flat areas and plains. Thus, the city of Fereydoun-Shahr with a height of 2560 meters above sea level is the highest in Isfahan Province, but in its areas close to the entrance to Tiran and Karvan, elevation is reduced to altitudes of 1860 meters above sea level. This shows a change from mountains to plains. The largest part of the area is located in the plains due to its relatively moderate climatic conditions. The study of the distribution of the sites in relation to the topographical factor were mapped and based on elevation levels dispersion of the Iron Age III settlements which are indicated in Figure 2.

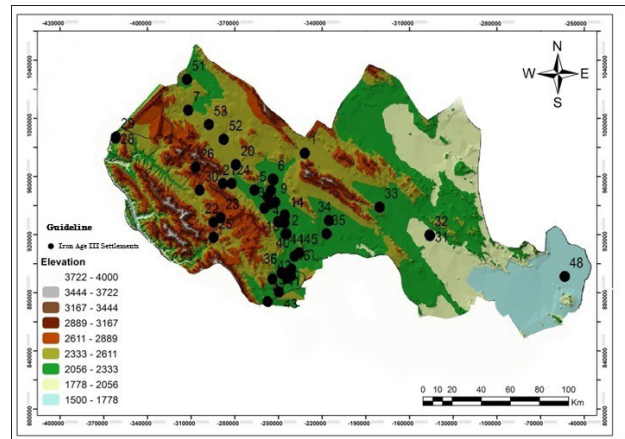


Figure 2. Dispersion of iron age III sites relative to altitude

Source: Field Survey (2017).

The zoning of the area in question is shown in Figure 2. Based on this feature, the area is divided into nine levels of elevation. The highest elevation is between 4000 and 3722 meters and the lowest elevation level is between 1,778-1,500 meters. The map (GIAS) shows that the majority of our study sites are at lower altitudes with 69.3% (33 sites) at an altitude of 2033-2333 meters, 18.9% (9 sites) at an altitude of 1800-2000 m, 10.5% (5 sites) at an altitude of 2600-2800 m, and 1.2% (1 site) at an altitude of 1700-1900 m; no remains of settlements were discovered at altitudes of 3167 up to 4000 meters. Most of the sites are located in the middle of the mountain plains. The average heights of most sites in the study area is in the range of 2333 to 2056 m. In fact, due to the presence of extreme slopes and high altitudes, the area provides a suitable area for human settlements along valleys and riversides. Furthermore, some sites are located at the intersection of mountains and plains. The study area is located in the highlands of Isfahan Province, particularly Daran and Fereydoun-Shahr city. Establishment of settlements at high altitudes was due to adequate rainfall and vegetation, particularly rangelands. At lower altitudes, habitation was established because of easier access to water resources and communication routes. The formation of settlements at high altitude were for the following reasons: 1- the need for security; 2-the availability of resources; 3-the existence of pastures; and 4- the existence of a fertile soil.

6.3 Location of the Sites Relative to the Slope of the Land

Slopes are one of the most important factors in the

transformation of the roughness of the earth's surface [34], and thus directly or indirectly affects human life and activities. The most suitable slopes for the establishment and development of cities are between 0.5 and 10% [35]. Considering the importance of slope in agricultural, constructional and residential uses, the use of slope factor with other parameters can be an important contribution to measuring the power of the regions. Agriculture and particularly crop activities as the predominant employment in many rural settlements have a close relationship with slopes. In principle, it is possible to carry out agricultural activities, particularly crop growth at low altitudes. The analysis of the topographic factor and its role in the stability of settlements, regardless of slope, does not seem reasonable [36]. Low slope percentages result in better penetration of water to the ground and increased moisture storage, thus, it is very effective in keeping better heat storage in plants and livestock production. 56.7% of sites (27 sites) were situated at slopes of 0.08 degrees, 27.3% (13 sites) at slopes of 9-22, 14.1% (7 sites) at slopes of 23-40 and 2.1% (1 site) on flat ground without a slope (Figure 3).

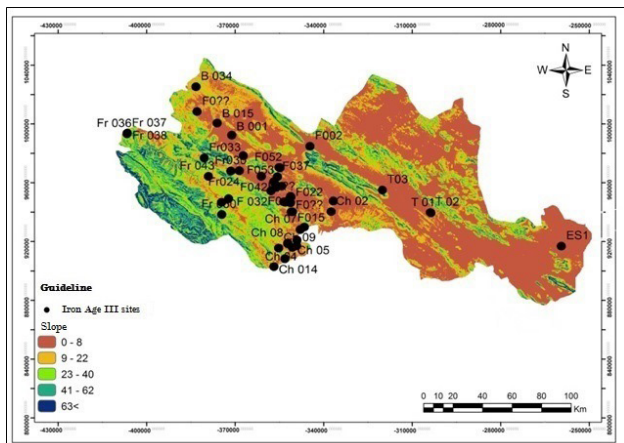


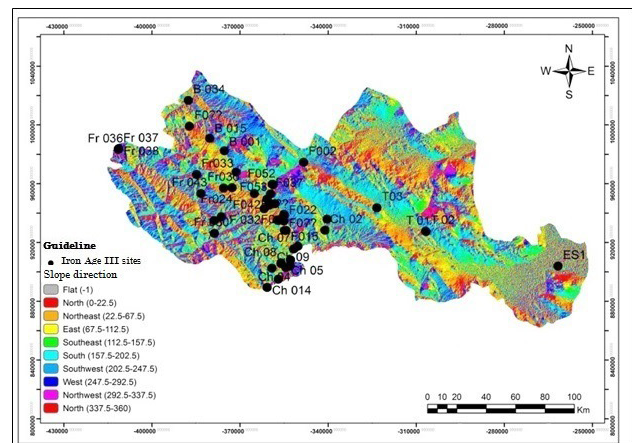
Figure 3. Dispersion of Iron Age III sites relative to the slope of the land

Source: Field Survey (2017)

6.4 Position of the Enclosures Relative to the Slope Direction

One of the most important influences on the ecological environment is the amount of sunlight received. 16.8% (8 enclosures) faced east, 7.35% (17 sites) faced south-east, 31.5% (15 sites) faced west, 8.4 (4 enclosures) faced north, 2.58% (1 site) was on a plain without facing any particular direction and 5.3% (3 sites) faced the south

(Figure 4).



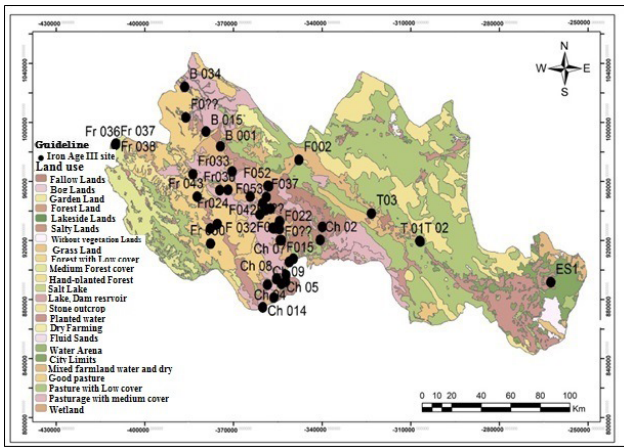


Figure 5. Dispersion of Iron Age III relative to land use
 Source: Field Survey (2017)

In the current research, land use was studied in relation to agriculture and rain water. This feature contributes to the proper position of grazing livestock and agriculture, which indicates the livelihoods of agriculture and livestock at high ranges. Due to the availability of adequate water resources at high altitudes and suitable rangelands and soils in the plains, the study area had favorable conditions for agriculture and horticulture. At high altitudes, due to the presence of pastures, it was a favorable region for the nomadic tribes and was suitable for livestock grazing. In mountainous areas, conditions were created for aquaculture along with rainfed farming. The location of the sites indicates climatic variation in terms of vegetation and was a favorable environment for crop (dry and irrigated) and livestock farming.

6.6 Situation of Sites in Relation to Today’s Settlements

Creating a modern settlement on ancient sites suggests the continuity of settlements in remote areas in a geographic environment. According to the surveys, only 3 enclosures are located adjacent to today’s population centers, and the rest of the sites are not related to large populated areas (Figure 6). However, during the survey it became clear that almost all of the sites are near the present-day villages, and this reflects the similarity of the current settlement pattern to that of the past suggesting continuity. This can be a sign of the existence of the proper and identical conditions of life from the past to the present. If we look at the present-day maps of the studied area, it is clear that all of today’s settlements were created alongside communication paths as a linear settlement pattern.

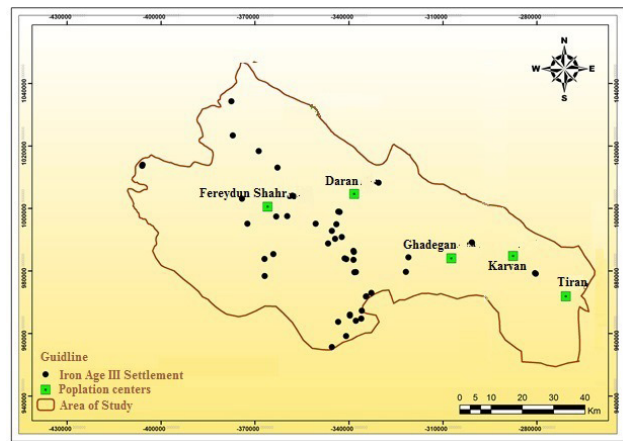


Figure 6. Dispersion of Iron Age III sites relative Population centers
 Source: Field Survey (2017)

6.7 Location of the Sites and Distance to the River

In Iran, mountains account for many of Iran’s spatial features such as rainfall, vegetation, water and ice equilibrium, and most importantly the central civilization of Central Iran. In Zagros forests, the presence of water is much higher in the eastern part of the mountains and only approximately half of the annual precipitation is received compared to the western slopes [38]. The natural source of water in the studied area includes permanent and seasonal rivers as well as springs. The most important feature of water resources in this region is the seasonal surplus of water limited only to winter months. This abundance of water resources led to the emergence of rich habitats and attracted people to the study area in the first millennium BC. These kind of water resources makes this area a prerequisite for the settlement of demographic groups.

Due to the existence of water resources, the highest population densities were located in Daran, Fereydoun-Shahr, and Chadegan so that almost all of the sites are located on the alluvial terraces of the Zayandeh-Rud River and Palasjan Rivers. Considering the existence of Zayandeh-Rud River and its branches, this river is the main focus of populations and economy in the region. Other seasonal rivers also provide conditions for a group of temporary and seasonal habitats for migrants. Generally, seasonal settlements created in Iron Age III in these mountainous regions were planned for the same amount of water resources. In Chadegan and Tiran, due to decreasing slope, the amount of submerged river sediments caused valleys and surrounding lands to be more fertile and cultivated. The dispersal of ancient sites and settlements, particularly in Chadegan, follow the course of Zayandeh-Rud River and its related branches. Changes

in the Zayandeh-Rud River and the fluctuation of glacial heights around Isfahan are also factors influencing the formation of human settlements in the west and northwest of Isfahan. The strip of inter-connected nodes or the remains of glacial lakes in villages and townships is still visible [39]. Figure 7 illustrates that more than 95% of the settlements were within 500 meters of the water source.

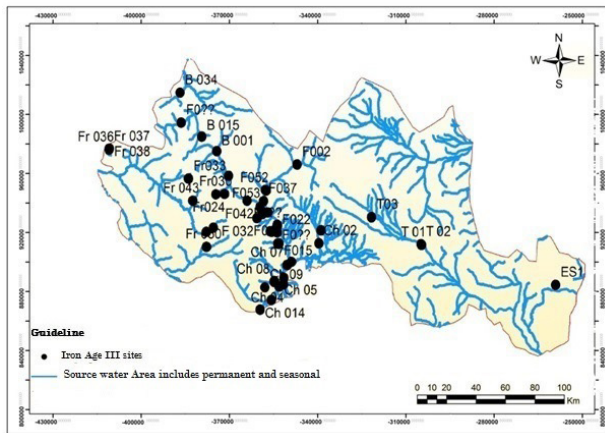


Figure 7. Dispersion of Iron Age III sites relative distance to the river

Source: Field Survey (2017)

6.8 Location of Sites in Relation to the Region's Climate

The magnitude of the impact of geographical and climatic factors (such as altitude, vegetation, etc.) is indicative of the weather in the area, thus providing a clear and comprehensive picture of the weather in each region [40]. The importance of climate in the formation of human settlements is such that changes in climatic elements can disturb the ecological balance of habitats. The most important climatic elements that have great influence are temperature and precipitation [41]. Despite the importance of elevation in the settlements, weather and its prominent role in determining the structure of the settlement pattern has a greater influence. An ancillary study of two caves and ancient fortresses dating back to the Middle Ages, approximately 60,000 to 40,000 thousand years ago provided new information regarding the vegetation and animal life of the Zayandeh-Rud River basin. The study of charcoal samples shows that in this period there were some tree-covered beams along the shrublands including those of willows and poplar trees. There were also pistachio forests in the area during this period. The inhabitants of the Ghaleh Bozi used these trees as fuel for their stoves [42].

Moreover, a survey to identify the amount of carbonate

in the soil and the effect of greenhouse gases during the Quaternary glacial period on soil type in the eastern part of the city of Isfahan, between Zayandeh-Rud River Dam in Chadegan and Gavkhoni Lagoon, was carried out in 2004. The extent and type of vegetation and climate in the region was also discovered. In this study, plants from the spongy family were identified and its spread over the last glacial period in the catchment area of Zaryar and Mirabad lakes were identified to be as a result of the dominance of the cold and dry climatic conditions in western Iran [43]. The results show that the current climate in the region is not significantly different from the past. 7.35% (17 sites), 37.8% (18 sites), 8.26% (8 sites), 6.8% (3 sites), and 8.4% (4 sites) of sites, were semi-arid, semi-humid, humid, medium semi-dry and dry areas, respectively illustrating the pattern of migration to semi-humid areas. Of course, the issue of precipitation has also been very important in this regard because rainfall is crucial to both agriculture and livestock farming. The amount of rainfall and access to the river are also very important. The greatest transaction and proximity of the sites are in medium to high rainfall areas, which might be justified by groups based on selective livelihoods.

6.9 The Location of the Enclosures Relative to the Distance from the Roads and Communication Paths

Low degree of slope in the areas provided better access to communication paths. Mobility with the help of the road network aided transportation and movement of populations and expansion of trade. Most of the sites are located along today's communication paths. It is noteworthy that communication paths are needed in every region's economic development. Livestock activities and even livestock need roads and require communication paths to exchange products. The area has several passageways which have been used by nomadic tribes since ancient times. The studied area has the most commonly used passageways which

were used by nomadic tribes in the distant past. For these reasons, there is still a road connection. Due to the existence of mountainous areas, communication paths were required for establishing regional and trans-regional relations with the lowlands. As far as the distance and proximity of the sites are concerned, four levels were considered: the first floor was 0-500 meters, the second floor was 1500-500 meters, the third floor was 2500-1500 meters, and the fourth floor was 3500 -2500 meters. In terms of correlation with communication routes, 37.8 percent (18 sites) of sites were at 500 meters, 25.2 percent (12 sites) were at 1500 meters, 23.1 percent (11 sites) were at 2500

meters and 12.6 percent (6 sites) were at 3500 meters (Figure 8).

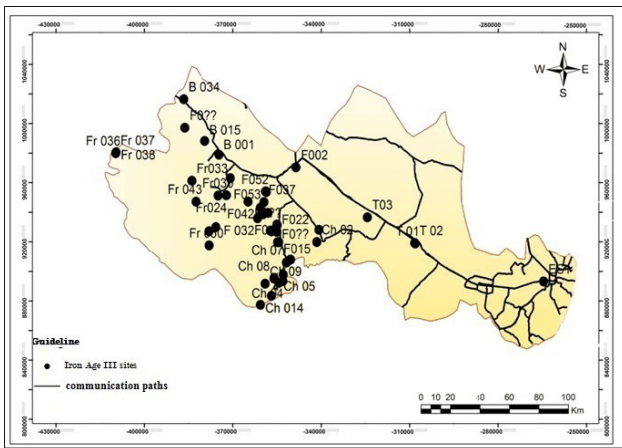


Figure 8. Dispersion of Iron Age III sites relative to the distance from the roads and communication paths

Source: Field Survey (2017)

6.10 Location of the Sites in Relation to the Geological Structure and Faults of the Region

Looking at human settlements, it can be observed that most of these sites, and even today’s villages, tended to reside in the middle of the plains and almost all maintained their distance to the mountains. This indicates that cold weather is an important factor in human habitations beings near plains and away from heights. Some of the sites such as Asgaran in Tiran and Krone settled between the mountains and the plains.

Environmental changes in the Quaternary period are important in terms of renewable natural resources, land use, erosion sensitivity, underground and surface water storage, dependent vegetation, the determination of archaeological age, and many other important issues. In geological studies and in terms of stratigraphic divisions, Quaternary period is considered the third geological age (Cenozoic) and is approximately equal in length to the approximate length of the Holocene and Pleistocene eras. During this period, due to the presence of atmospheric rainfall, large floods were created and floods in turn carried the material from the heights to the downstream areas (Figure 9).

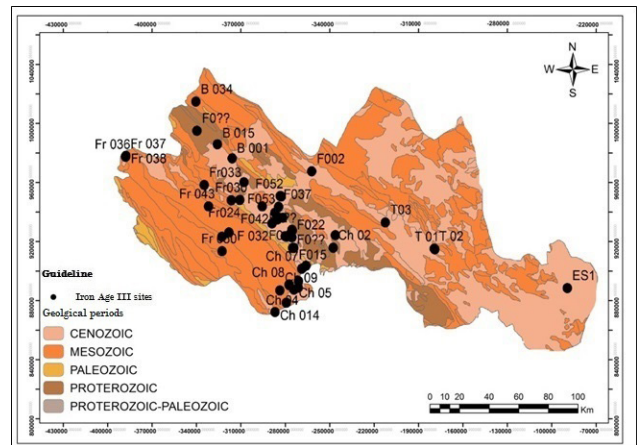


Figure 9. Dispersion of Iron Age III sites relative to the faults of the region

Source: Field Survey (2017)

In this way, alluvial deposits have been the most common among quaternary deposits. Alluvial soils are suitable for agricultural activities. In the atmospheric rainfall in the Ice Age during the Quaternary period, the lignite line hosted by the (impenetrable) rocks created numerous lagoons. Figure 10 shows that the sites under study covered the second and third periods of geology. 69.3% of the sites were Quaternary (33 sites), 10.5% were Cretaceous (1 site), 8.4% were Peruvian Toucu before Cretaceous (4 sites), 10.5% (5 sites) were of the Jurassic Age (Figure 10). Establishments along the faults was because of easier access to groundwater resources.

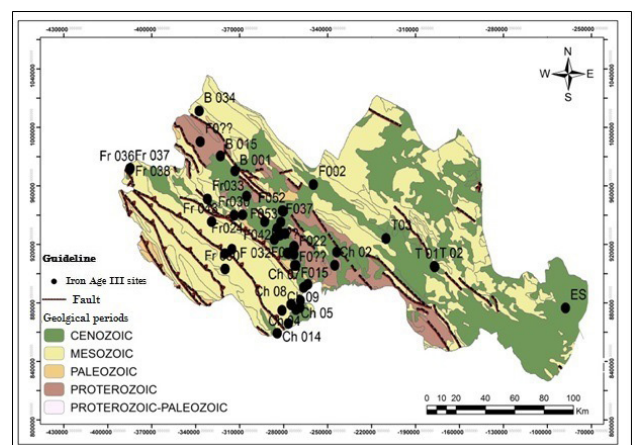


Figure 10. Dispersion of Iron Age III sites relative to the geological structure

Source: Field Survey (2017).

7. Discussion and Conclusion

Natural environment has a great influence on the distribution and location of ancient sites, and is one of the

factors contributing to the appearance of the sites. Using GIS software helped us to increase the speed and strength of analysis and conclusions. In this research, the effect of natural factors such as height, water resources, climate, land use, percentage and direction of slope, distance and proximity to communication paths and geological structure of the study area were compared to the distribution of the Iron Age III settlements in the west and north of Isfahan Province.

Investigating the distribution patterns of the ancient sites of Iron Age III in this geographical area shows that human populations were able to overcome the natural environment. There are two different views in this area: one of the heights and the other open valleys leading to the plains, so the chosen settlement pattern is in line with the same environmental characteristics of the area. The open valleys leading to the fertile plains along with the alluvial deposits of the Zayandeh-Rud River and its sub-branches in the plains have the most settlements.

Given the environmental conditions prevailing in the area, most of the identified sites are of temporary settlements (extramural). The characteristics of these sites are small, and the number of low cultural materials is superficial and not thicker than their ancient deposits. Today, in the villages of Chadegan, nomadic tents are still seen. The mentioned environmental factors influenced the formation of Iron Age III settlements in the target area. Evidence suggests that the west and northwest of Isfahan played a significant role in Iron Age III. As a result of the archaeological study of west and northwest of Isfahan Province, 53 Iron Age III areas were identified. According to the maps prepared by GIS, the factors of height, proximity to water resources, distances and proximity to communication paths are the most important factors in distribution and location of the settlements. Therefore, the establishment of settlements in the study area was influenced by the environmental conditions of the region, confirming the existence of Zayandeh-Rud River watershed and its branches led to the creation of permanent water resources in the region which in turn created suitable conditions for habitation and fertile soils necessary for agriculture. The existence of medium to high rangelands at high altitudes formed suitable conditions for livestock farming an important factor in nomadic lifestyles.

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